CLAIMS

1. A method for the production of titanium compounds, comprising the steps of mixing aluminium with a precursor material including titanium subchloride, and heating the mixture, to form aluminium chlorides and titanium compounds.

2. A method in accordance with claim 1, comprising the step of arranging reaction conditions to favour a forward reaction to form the aluminium chlorides and titanium compounds.

3. A method in accordance with claim 2, wherein the step of arranging the reaction conditions involves driving aluminium chlorides away from a reaction zone where the aluminium and precursor material are reacting.

4. A method in accordance with claim 3, wherein the step of arranging the reaction conditions includes a continuous removal of aluminium chlorides from the reaction zone.

5. A method in accordance with any one of the preceding claims, comprising the step of preparing the titanium subchloride precursor material from titanium chloride ($TiCl_4$).

6. A method in accordance with claim 5, comprising the step of preparing titanium subchloride by reduction of $TiCl_4$ using aluminium.

7. A method in accordance with claim 5, wherein the step of preparing titanium subchloride is carried out by heating $TiCl_4$ in a plasma of an argon-hydrogen mixture.

8. A method in accordance with claim 6 or claim 7, comprising the further step of recycling at least some of the aluminium chloride formed, and utilising the aluminium chloride to produce $TiCl_4$.

9. A method in accordance with claim 8 wherein the aluminium chloride is used to reduce titanium oxide to produce $TiCl_4$.

10. A method in accordance with claim 9, wherein aluminium oxide is produced by the reduction of titanium oxide and the aluminium oxide is electrolysed to produce aluminium raw material for use in the method of any one of the preceding claims.

11. A method in accordance with any one of claims 3 to 10, wherein the aluminium chlorides are condensed away from the reaction zone at a temperature lower than that in the reaction zone.

12. A method in accordance with any one of claims 3 to 11 wherein titanium subchloride which escapes the reaction zone is condensed at a temperature different to that in the reaction zone.

13. A method in accordance with claim 12, comprising the further step of returning the condensed titanium subchloride to the reaction zone.

14. A method in accordance with any one of the preceding claims, wherein the precursor material includes vanadium subchloride, and a product of said method is an alloy or intermetallic complex including titanium, aluminium and vanadium.

15. A method in accordance with claim 14, comprising the steps of mixing the precursor material in appropriate proportions and carrying out the method to produce Ti-6Al-4V.

16. A method in accordance with claim 14, wherein the precursor material includes zirconium subchloride, and a product of the method is an alloy or intermetallic complex including titanium, aluminium, zirconium and vanadium.

17. A method in accordance with any one of claims 1 to 13, wherein the precursor material includes niobium halide and chromium halide, and a product of said method is an alloy or intermetallic complex including titanium, aluminium, niobium and chromium.

18. A method in accordance with claim 17, comprising the steps of mixing the precursor materials in

appropriate proportions and carrying out the method to produce Ti-48Al-2Nb-2Cr.

19. A method in accordance with any one of claims 1 to 13, wherein the precursor material includes a source of one or more elements selected from the group comprising chromium, niobium, vanadium, zirconium, silicon, boron, molybdenum, tantalum and carbon, and products of said method include titanium-aluminium compounds which include one or more of these elements.

20. A method in accordance with claim 19, wherein the source of the element(s) can be a metal halide, a subhalide, a pure element or another compound which includes the element.

21. A method in accordance with claim 19 or claim 20, wherein the products also include one or more of an intermetallic compound, a titanium-(selected element)-alloy, and intermediate compounds.

22. A method in accordance with any one of the preceding claims, wherein the aluminium is added in the form of a powder having an approximate upper grain size of less than about 50 micrometres.

23. A method in accordance with any one of claims 1 to 21, wherein the aluminium is in the form of a powder of an approximate upper grain size of greater than about 50 micrometres, and the method comprises the step of milling the aluminium powder and titanium subchloride to reduce the grain size of the aluminium powder in at least one dimension.

24. A method in accordance with any one of claims 1 to 21, wherein the aluminium is in the form of flakes having a thickness in one dimension of less than about 50 micrometres.

25. A method in accordance with any one of the preceding claims, comprising the further step of adding a reagent to a product of the method to produce a further product.

26. A method in accordance with any one of the preceding claims, including a pre-processing step of forming the titanium subchloride as precursor material.

27. A method of producing titanium-aluminium compounds, comprising the steps of:
- heating a precursor material of $TiCl_4$ in a plasma of an argon-hydrogen mixture to produce $TiCl_3$;
- mixing aluminium with said $TiCl_3$; and
- heating the resultant mixture to produce titanium-aluminium compounds and $AlCl_3$.

28. A method of producing titanium-aluminium compounds, comprising the steps of:
- heating a mixture of $TiCl_4$ and aluminium to form $TiCl_3$ and $AlCl_3$;
- heating the mixture to a reaction zone temperature above 300C and providing for $AlCl_3$ to be evaporated from the reaction zone;
- adding further aluminium to the mixture; and
- heating the mixture to a temperature above 300C to form $AlCl_3$ and titanium-aluminium compounds.

29. An apparatus for the production of a metal compound, comprising:
- a reaction vessel arranged in use for the mixing of aluminium with a precursor material of metal halide;
- the vessel also arranged in use for the resultant mixture to be heated to a temperature sufficient for the precursor material to react with the aluminium to form aluminium halide and a product; and
- a first condensation zone arranged in use to operate at a temperature such that the aluminium halide condenses in the first condensation zone.

30. An apparatus in accordance with claim 29, also comprising a second condensation zone arranged to condense metal halide escaping the reaction mixture.

31. An apparatus in accordance with claim 30, wherein the

second condensation zone is arranged to return condensed metal halide to the reaction zone.

32. A method for the production of a metal compound, comprising the steps of:

- mixing aluminium with a precursor material of metal halide;
- heating the mixture to a temperature sufficient for the precursor material to react with the aluminium, resulting in the formation of aluminium halide; and
- arranging the conditions to favour a forward reaction to form the aluminium halide and to reduce a reverse reaction to form aluminium and precursor material.

33. A method in accordance with claim 32, wherein the step of arranging the reaction conditions includes the step of driving aluminium halide away from a reaction zone where the aluminium and precursor material are reacting.

34. A method in accordance with claim 32 or claim 33, wherein the metal halide is a titanium subhalide, and a product of the reaction includes titanium compounds.

35. A method in accordance with any one of claim 32 to claim 34, wherein the precursor material can include a source of one or more elements selected from the group comprising chromium, niobium, vanadium, zirconium, silicon, boron, molybdenum and carbon.

36. A method for the production of vanadium and/or vanadium compounds, comprising the steps of mixing aluminium with a precursor material including vanadium subhalide, and heating the mixture, to form aluminium halides and vanadium and/or vanadium compounds.

37. A method in accordance with claim 36, wherein the vanadium compounds may include vanadium-aluminium alloys and/or vanadium aluminium intermetallic

complexes.

38. A method for the production of zirconium and/or zirconium compounds, comprising the steps of mixing aluminium with a precursor material including zirconium subhalide, and heating the mixture, to form aluminium halides and zirconium and/or zirconium compounds.

39. A method in accordance with claim 38, wherein the zirconium compounds may include zirconium-aluminium alloys and/or zirconium-aluminium intermetallic complexes.

40. A method for the production of titanium and/or titanium compounds, comprising the steps of mixing a reducing agent with a precursor material including titanium subhalide, and heating the mixture, to form halides of the reducing agents and titanium and/or titanium compounds.

41. A method in accordance with claim 40, wherein the reducing agent is selected from the group comprising zinc, magnesium, sodium, aluminium or other like metals.

42. A method for production of a powder of titanium-aluminium intermetallic compounds including at least one of Ti_3Al, TiAl and $TiAl_3$, and alloys based on titanium-aluminium intermetallics according to any one of claims 1 to 18, wherein starting materials for the method include aluminium powder and at least one of titanium chloride or a titanium subchloride.